

## Note on *Donatia novae-zelandiae*, Hook. f.

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With Plate LVIII.

*DONATIA NOVAE-ZELANDIAE*, Hook. f., is a little cushion plant of moss-like habit, growing on the heights of New Zealand and Tasmania. With *Donatia fascicularis*, Forst., found in antarctic America, it forms an isolated genus *Donatia*, the systematic position of which has been much debated. Hooker,\* who first described it, referred the genus to Saxifrageae. At the same time he pointed out that the insertion of the stamens within an epigynous disk, the extrorse anthers, and the pendulous placentation were characters which pointed to an affinity with Stylidiaceae. Subsequently Von Mueller† definitely included the genus in the Stylidiaceae. Engler,‡ however, retained it in Saxifragaceae as a special tribe, the Donatieae, of his larger group the Saxifragoideae, and Schoenland§ also definitely excluded the genus from Stylidiaceae.

More recently Mildbraed,|| following the lead of Von Mueller, has taken *Donatia* to be a constituent subfamily, Donatioideae, of the Stylidiaceae, which otherwise includes the subfamily Stylidioideae only. We may admit with Mildbraed that the position of the Stylidiaceae amongst the Campanulateae is assured, and also that the relationship with the Campanulaceae themselves is perhaps not so close as has been urged. Whether, however, there is ground for saying, as he does, that the Stylidiaceae, as he constitutes it, is to be regarded as a small independent branch of the Campanulateae which has taken origin in the antarctic, is a matter for further consideration. Is his family of the Stylidiaceae really a natural one? The Stylidioideae with sympetalous flowers and a gynostemium, and the Donatioideae with a chori-

\* Fl. Nov. Zel., i, p. 81, t. 20.

† Nuov. Giorn. Bot. Ital., xi, July 1879.

‡ Engler in Engler and Prantl, Natürliche Pflanzen-Familien, iii, 2a, p. 67.

§ Schoenland, Candollaceae in Engler and Prantl, Pflanzenfam. iv, 5, p. 283.

|| Mildbraed, Stylidiaceae in Engler's Pflanzenreich iv, p. 278.

[Notes R.B.G., Edin., No. XXII, November 1911.]

petalous corolla and free stamens, appear to him without doubt to have relationship, from the fact that the leaf-structure in the two subfamilies agrees, and both have inulin as a reserve material. Their general habit also is alike. There is no doubt that except for the extrorse anthers the evidence is all in favour of *Donatia* being placed in the alliance of the Campanulateae rather than in the family of the Saxifrageae, as was the case in the older classification; but the justification for Mildbraed's further step of combining the subfamily Donatioideae with the subfamily Stylidioideae in the subfamily Stylidiaceae is not at all evident. The differences between these two groups seem as great as, if not greater than, those between any of the families of the Campanulateae. Compare, for example, the Campanulateae and the Stylidiaceae: in the former we have the flower actinomorphic, 5-merous, sympetalous, except for the 3-merous gynoeceum, the anthers are free, introrse, and there is one style with collecting hairs; in the latter the flower is zygomorphic, 5-merous in perianth, sympetalous, and with two stamens united with the style in a styler column. In relation to these *Donatia* shows a flower which is actinomorphic, choripetalous, 5-merous in the perianth, the stamens 2-3 free from the style, and the ovary divided into 2-3 chambers. Such evidence might warrant, surely, *Donatia* being regarded as a distinct order, Donatiaceae, of the cohort Campanulateae, rather than as a subfamily of the Stylidiaceae.

No observations seem to have been recorded of the morphology of *Donatia novae-zelandiae* (Fig. 1), and I therefore take opportunity to make known a few facts which I have been able to observe in material of the plant obtained from specimens sent to the Regius Keeper, Royal Botanic Garden, Edinburgh, by Dr. Cockayne, who collected it on the heights of Stuart Island, New Zealand.

STEM.—In a transverse section the stem of *Donatia novae-zelandiae* shows (Fig. 3) a central mass of xylem with fairly large development of cortex and cork. The pith is relatively small, and composed of large slightly thickened cells. Surrounding the pith is the xylem, composed of regular tracheids—spiral, reticular, and annular. There is little xylem parenchyma. Where a side branch is given off, the xylem tracheids are elongated in a radial direction. Phloem is found in patches around the xylem. An endodermis, of sometimes one distinct layer, sometimes more, of oblong thickened cells with granular contents, is present. Usually these cells lie adjacent, but often project slightly one towards the other (Fig. 3*d*). The cortex is largely developed. The cells composing it are round and fairly uniform in size, slightly thickened and loosely arranged with large intercellular spaces. No resiniferous secreting system such as is said to occur

in *Donatia magellanica* \* is visible here. Bounding the cortex on its outer side are two or three rows of cork cells. They are different from those of the cortex, being squarish in shape, with thickened walls, and they are filled with oily and granular contents. From the outermost layer, at intervals, obliquely septate hairs are given off, the basal cells of which contain oily and granular matter like the cork cells (Figs. 3 and 4).

HAIRS.—The characteristic septate hairs of *Donatia novae-zelandiae* are silky in appearance, and form a dense matting at the base of the leaves which are closely adpressed to the stem. The ends of these hairs are sharp and bayonet pointed (Fig. 4a). The cell forming the point is long. The septa are oblique and distinctly pitted and perforated, slightly overlapping on either side at the junction of two cells (Fig. 4b). The cells on either side of such a junction are empty and colourless, but occasionally they are thickened. The hairs are comparatively long, and consist generally of ten or twelve cells. The basal—one to three—cells are cork cells and are quite different from the others. They are smaller, have horizontal septa, are brown in colour and have a distinct granular content, a nucleus, and a thickened wall. The lowermost of the basal cells is the shortest, and the others are gradually longer until they merge into the empty, colourless cells (Fig. 4d). The whole structure of the hair is unique, and the presence of the perforated oblique plate-septa may, in a xerophytic herb like *Donatia*, possibly be for the purpose of water absorption. Among these hairs is found an epiphytic fungus to which I shall refer later.

LEAVES.—The leaves are packed closely round the stem, and are densely covered with the silvery grey hairs at the base, which is not narrowed into a petiole. The leaf changes in anatomical character from its base to its tip.

At the base, where it is attached to the stem, the leaf has an irregular triangular outline, with one vascular bundle in the centre (Fig. 6). The epidermis which bounds the leaf is formed of small, regular cells with a thick cuticle. A few stomata occur on the under surface, and these have no subsidiary cells, differing in this also from what is known of *Donatia magellanica*.† The mesophyll is not differentiated, the leaf being symmetrical, and consists of slightly-thickened cells, somewhat collapsed to the corners of the triangle. Owing to crushing, these cells are sometimes locally thickened and infolded, particularly at the corners, somewhat after the manner, though not to such an extent, as that of the infolded mesophyll of *Pinus sylvestris*. The vascular bundle is irregular in outline, with no bounding endodermis. The xylem

\* Solereder, Systematische Anatomie der Dicotyledonen, p. 355.

† Ibid. p. 353.

in the centre of the bundle is well marked, as is the phloem which surrounds it. Mucilage cells are abundant.

Similar appearances to the foregoing are found from the base of the leaf to about the centre, where the single median nerve divides, giving off two side veins, and thus a section across the centre of the leaf shows three vascular bundles (Fig. 7). The leaf is now more symmetrical in shape, losing its triangular form and becoming somewhat oval. The cells of the mesophyll are large and regular. The bundles are similar to the median nerve in the basal section, but, on the outer side of each bundle, sclerenchyma is developed. Stomata are occasionally found, and mucilage cells are more abundant. As might be expected from the habit of growth, the tips of the leaves differ considerably in structure from the basal and central portions (Fig. 8). This is the exposed part of the leaf, and stomata are very abundant. Passing upwards to the tip of the leaf, the cuticle becomes lighter in colour and very thick, the mesophyll is differentiated into long, palisade cells under the epidermis and loosely-arranged cells towards the centre of the section, first occupied by three vascular bundles, but later by one, as the tip of the leaf is reached. There is a large amount of schlerenchyma developed on the outside of the bundle.

### Fumago Donatiae, Chandler.

An Epiphytic Fungus occurring on *Donatia novae-zelandiae*,  
Hook. f.

*Descr.*—Effusa hyphis late racemosis; cellulis brevibus crassis; conidiis catenulatis, sphaericis v. sphaericocuboideis; hyphis fertilibus raris; sed crebro filamentis conjugatis.

*Hab.*—Inter pilos circa caulem *Donatiae novae-zelandiae*.

Intermingled with the hairs of *Donatia novae-zelandiae* is found the mycelium of a fungus. The fungus is epiphytic, for its mycelium merely twines in and out among the hairs of the stem, and lies on the epidermis, not actually piercing the tissue (Figs. 5 and 9). The filaments of the mycelium consist of thick-walled cells of an intense brown colour (Figs. 5 and 10), and they branch freely—the young branches being delicate and colourless. Bead-like gonidia are found on the mycelium (Fig. 10a). We know from De Bary\* that a resting mycelium stage and resting gonidia are common in starved specimens of *Fumago*, *Penicillium*, and *Pleospora*. In this and other characters the fungus on *Donatia* resembles species of *Fumago*, the soot-fungus.

\* De Bary, Comp. Morph. and Biol. of the Fungi, Mycetozoa, and Bacteria.

Under favourable conditions the mycelium and the gonidial cells pass from the condition of rest. After one day in water the mycelial threads swelled, and new transparent filaments were visible. After two days in water several of the gonidia had germinated, bursting the thick wall, giving rise to a promycelium.

Although *Fumago* is classed with the *Ascomycetes*, its life-history is not yet clear. Fertile hyphae are rarely seen, but in the species on *Donatia*, now under notice, twisted filaments, such as are found forming an ascocarp in *Penicillium*, were observed twice.

Conjugation of filaments, a feature that is not described in any one of the six species of *Fumago* mentioned by Saccardo,\* is, however, common in the fungus on *Donatia* (Figs. 10 and 11). Two filaments may be seen lying parallel for the length of several cells, and a protuberance grows out from one cell only of one of the filaments until it reaches a cell of the parallel filament; it then fuses with it, and forms a distinct bridge between the filaments (Figs. 10c, 11a). The more common method of conjugation seems to be that a protuberance is formed simultaneously on two cells lying opposite on the parallel filaments, and these, growing out to each other, meet, and the bridge is thus formed by their union.

The variation is quite in accordance with Zopf's description of *Fumago*.† De Bary, too, cites this fungus as an example of a cycle of forms still more copious and various than that of *Pleospora* or *Nectria ditissima*.

\* Saccardo, *Syllogae Fungorum*, iv, 547; xi, 638; xix, 1099.

† Zopf, *Nova Acta Leopold*, xl.

## EXPLANATION OF PLATE LVIII.

Illustrating Miss Chandler's paper on "*Donatia novae-zelandiae*,  
Hook. f."

- FIG. 1. Portion of cushion of *Donatia novae-zelandiae*. Nat. size.
- FIG. 2. a. Flower of *Donatia novae-zelandiae*. ( $\times 3$ )  
b. Same showing stamens, corolla and calyx absent. ( $\times 3$ )
- FIG. 3. Transverse section of stem of *Donatia novae-zelandiae* ( $\times 140$ )—  
a. Pith.  
b. Xylem.  
c. Phloem.  
d. Cells of endodermis projecting towards one another.  
e. Cortex.  
f. Cork cells.  
g. Septate hairs.
- FIG. 4. Hairs on stem shewing ( $\times 280$ )—  
a. An end cell.  
b. Oblique septum, side view.  
c. Oblique septum, front view.  
d. Basal cells filled with granular contents.
- FIG. 5. Epiphytic fungus among hairs of *Donatia novae-zelandiae* ( $\times 140$ )—  
a. Hair.  
b. Fungus.
- FIG. 6. Transverse section of leaf at base. ( $\times 35$ )  
a. Infolding of cell-walls due to crushing.  
b. Mucilage cells.
- FIG. 7. Transverse section of leaf at centre. ( $\times 35$ )  
a. Mucilage cells.
- FIG. 8. Transverse section of leaf near tip. ( $\times 35$ )  
a. Stomata.  
b. Sclerenchyma.
- FIG. 9. General view of epiphytic fungus among hairs. ( $\times 50$ )  
a. Hairs.  
b. Fungus.
- FIG. 10. Epiphytic fungus on *Donatia novae-zelandiae* ( $\times 200$ )—  
a. Gonidial cells.  
b. Young filaments.  
c. Stages in conjugation of filaments.
- FIG. 11. a. Filaments of fungus showing conjugation. ( $\times 275$ )  
b. Hairs, oblique septum, side view.



